Public Health Assessment

Public Comment Release

WASHINGTON COUNTY LEAD DISTRICT-FURNACE CREEK AREA

WASHINGTON COUNTY, MISSOURI

EPA FACILITY ID: MON000705842

Prepared by
Missouri Department of Health and Senior Services

JUNE 23, 2014

COMMENT PERIOD ENDS: JULY 23, 2014

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment-Public Comment Release was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR's Cooperative Agreement Partner has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate. This document represents the agency's best efforts, based on currently available information, to fulfill the statutory criteria set out in CERCLA section 104 (i)(6) within a limited time frame. To the extent possible, it presents an assessment of potential risks to human health. Actions authorized by CERCLA section 104 (i)(11), or otherwise authorized by CERCLA, may be undertaken to prevent or mitigate human exposure or risks to human health. In addition, ATSDR's Cooperative Agreement Partner will utilize this document to determine if follow-up health actions are appropriate at this time.

This document has previously been provided to EPA and the affected state in an initial release, as required by CERCLA section 104 (i) (6) (H) for their information and review. Where necessary, it has been revised in response to comments or additional relevant information provided by them to ATSDR's Cooperative Agreement Partner. This revised document has now been released for a 30-day public comment period. Subsequent to the public comment period, ATSDR's Cooperative Agreement Partner will address all public comments and revise or append the document as appropriate. The public health assessment will then be reissued. This will conclude the public health assessment process for this site, unless additional information is obtained by ATSDR's Cooperative Agreement Partner which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Prepared by:

Missouri Department of Health and Senior Services
Division of Community & Public Health
Section for Environmental Public Health
Bureau of Environmental Epidemiology
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

This information is distributed by the Agency for Toxic Substances and Disease Registry for public comment under applicable information quality guidelines. It does not represent and should not be construed to represent final agency conclusions or recommendations.

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SUMMARY

INTRODUCTION

The top priority for the Missouri Department of Health and Senior Services (DHSS), in cooperation with the federal Agency for Toxic Substances and Disease Registry (ATSDR), in evaluating the public health impact of the Washington County Lead District – Furnace Creek Area site is to provide the communities with the best information possible to safeguard their health.

The Furnace Creek Area is one of the United States Environmental Protection Agency (EPA) National Priorities List (NPL) sites in Washington County that was listed primarily due to lead contamination of residential yards and private drinking wells from mining, milling, and smelter wastes. Also, there is concern for cadmium in drinking water and physical hazards left behind consisting of known and unknown diggings and shafts.

CONCLUSIONS

DHSS has reached four important conclusions in this public health assessment:

Conclusion 1 ***Soil***

Ingesting (swallowing) and/or inhaling (breathing) lead contaminated soil, dust, or tailings found in many of the residential yards/driveways within the Furnace Creek Area could harm individuals' health and presents a public health hazard. This conclusion applies to past, present, and future exposure to lead at this site.

Basis for Decision

Residential yards/driveways and mining areas throughout the Furnace Creek Area contain lead at concentrations above a level of health concern. The primary concern from exposure to lead in Washington County is the effect lead has on the nervous system, especially on children less than 72 months of age and the unborn children of expectant mothers.

EPA has removed soil from residential yards/driveways that contain lead concentrations above EPA's Time-Critical Removal Action level. These yards contained soil with lead contamination at a concentration of 1,200 parts per million (ppm) and greater or lead concentrations of 400 ppm and above for those that had a child less than 72 months of age with an elevated blood-lead level (10 µg/dL). After EPA's Time-Critical Removal Action and later the Remedial Action to replace lead contaminated soils with clean soil, the possibility of exposure to lead in these yards should be reduced. However, the best available science currently indicates

that no safe blood-lead level in children has been determined. Residential yard that have not been sampled and may have elevated levels of lead still pose the potential for exposure and could result in blood-lead levels above CDC' new childhood blood-lead reference value of 5 µg/dL.

Residential yards/driveways still remain in the Furnace Creek Area that have not been remediated by EPA and may contain lead contaminated soil above an EPA calculated health risk level of 400 ppm. Exposure to the soil in these yards may harm people's health. Individuals, especially children and expectant mothers, can be exposed to this contaminated soil directly by accidentally ingesting the soil while working, playing, gardening, or spending time in the yard. This contaminated soil can be tracked indoors on shoes, pets and other routes and accumulate in the home. Individuals, especially children, can accidentally ingest this contaminated soil in the home. Although not as major of a route as ingestion, individuals can also be exposed by inhalation to contaminated dust in the yard and contaminated dust in the home. When this soil or dust is stirred up and becomes airborne, individuals, especially children, may breathe it in and then clear it from their lungs and swallow it.

Conclusion 2
Groundwater

Drinking water with lead and cadmium from untreated private well water may harm individuals' health and presents a public health hazard. For residents with contaminated well water but who are drinking EPA-provided alternative source of water, there is no longer a health concern from exposure to lead and cadmium. Skin contact with or breathing in lead or cadmium from a contaminated drinking water well is not expected to harm individuals' health.

Basis for Decision

A number of private drinking water wells in the Furnace Creek Area were found to contain lead at concentrations greater than EPA's regulatory level of 15 parts per billion (ppb) for public water systems along with a well that contained cadmium above EPA's Maximum Contaminant Level (MCL) of 5 ppb. The primary exposure route to lead contaminated water is through ingestion. The primary concern from exposure to lead in Washington County is the effect lead has on the nervous system, especially on children less than 72 months of age.

EPA is currently using 15 ppb of lead as the site-specific action level in Washington County as a guideline for providing temporary alternative sources of water to private well users. For those individuals who are using EPA-provided alternative sources of

drinking water, they no longer need to drink water from their well; therefore, they are no longer being exposed to contaminated water through ingestion. However, for those having private wells with 14 ppb of lead and below, there is still some risk from exposure to the lead and residents should consider adding a treatment system or an alternative water supply.

For individuals who have refused EPA's temporary alternative sources of water or their well was not tested, they may still be drinking water from a contaminated private well. If these individuals are not drinking water from an alternative source or are not effectively filtering their well water, they may continue to be exposed to contaminants at levels that may harm people's health. No safe blood-lead level in children has been determined and drinking this contaminated water may be a contributing factor to elevated blood-lead levels.

Conclusion 3
Multi sources of lead

Past, present, and future exposure to lead contaminated paint and a number of other sources may be harmful to one's health, especially among children and expectant mothers.

Basis for Decision

The Furnace Creek area was the site of lead mining, processing, and smeltering since the early 1700s, and remnants of those activities remain in the environment. Besides the lead mining, 61% of the homes in Washington County were built before 1979 when lead-based paint was used. Lead paint remediation should be done using EPA guidelines or a certified lead abatement contractor.

Conclusion 4
Other pathways

DHSS cannot currently conclude whether exposure to lead through air, sediment, surface water, fish, and edible plants in the Furnace Creek Area could harm individuals' health. Physical hazards are also expected to exist in the past mining areas. The information needed to make decisions on these exposures is very limited.

Basis for Decision

The lead levels in these media vary greatly between mining areas. Limited sampling has been done in water bodies (streams, lakes, and impoundments), sediment, and fish associated with the mining areas in the Furnace Creek Area to determine if they contain elevated levels of contaminants. More testing is needed to determine if they may harm people's health.

NEXT STEPS

To protect residents:

1. During the Remedial Action phase, EPA will continue to sample untested residential soil and private well water and

remove soil from residential yards that contain elevated concentrations of lead that, if exposed to, may harm individuals' health.

2. EPA/Missouri Department of Natural Resources (MDNR) is expected to further sample other media, such as air, sediment, surface water, fish, and edible plants, so it can be determined if exposure to these media may harm individuals' health.

3. DHSS/ATSDR recommends that EPA eliminate physical hazards left from past mining activities as appropriate when found.

4. DHSS/ATSDR will coordinate with the Washington County Health Department, MDNR, and EPA to address community health concerns and questions as they arise by providing health professional and community education.

5. DHSS/ATSDR will coordinate with the Washington County Health Department, MDNR, and EPA to implement the recommendations in this public health assessment.

6. DHSS/ATSDR will continue to coordinate with the Washington County Health Department to provide health education to the residents of Washington County by informing them of the importance of having their residential yard soils and private drinking water tested for lead and cadmium and remediated when elevated levels are found.

7. DHSS/ATSDR will assist the Washington County Health Department in educating the public on the various pathways of exposure to lead and continue to promote prevention of lead exposure from all sources. We will also encourage residents of Washington County to have their children less than 72 months of age and expectant mothers blood-lead tested along with a yearly follow up blood-lead test.

8. DHSS/ATSDR will review and comment on any additional data from environmental samples collected by EPA, MDNR, or other agencies as it becomes available.

FOR MORE INFORMATION	If you have concerns about this Washington County Lead District – Furnace Creek Area Public Health Assessment, you should contact Arthur Busch or Dennis Wambuguh of the Missouri Department of Health and Senior Services toll free at (866) 628-9891 or direct at (573) 751-6102.

PURPOSE AND HEALTH ISSUES

The Missouri Department of Health and Senior Services (DHSS), in cooperation with the federal Agency for Toxic Substances and Disease Registry (ATSDR), is evaluating the public health impact of the Washington County Lead District – Furnace Creek Area. ATSDR, located in Atlanta, Georgia, is a federal agency within the United States (U.S.) Department of Health and Human Services and is authorized by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) to conduct public health assessments at hazardous waste sites. The purpose of this document is to assess the public health implications of exposures to environmental contamination and recommend actions to prevent or mitigate exposures.

The primary contaminant of concern in the Washington County Lead District – Furnace Creek Area is lead in soil and drinking water from mining, milling waste, former smelter areas, and the use of lead contaminated materials for other purposes (examples: driveways and landscaping). Physical hazards may also be present at some of the mining sites. To a lesser extent, there have been infrequent instances when cadmium was elevated in samples of soil or drinking water.

This public health assessment will determine if exposures to site related contaminants have occurred in the past, are presently occurring, or are likely to occur in the future at a level of health concern and recommend actions to reduce or prevent exposure and possible adverse health effects.

BACKGROUND

Site Description and History

The Washington County Lead District – Furnace Creek Area includes 175 square miles of the southeastern part of Washington County (See Figures 1 and 4). Washington County is part of the Old Lead Belt where lead mining, milling, and smeltering activities occurred for over 200 years. The Furnace Creek area is also part of the barite mineralization area that was the world's leading producer of barite before declining in the 1980s.

The Furnace Creek area lies directly south of Potosi, Missouri and encompasses the whole southeast corner of Washington County, including the towns of Caledonia, Irondale, and Belgrade. Potosi is located approximately 60 miles southwest of St. Louis, Missouri. The site is bordered on the south by Iron County and to the east by St. Francois County. The U.S. Environmental Protection Agency (EPA) proposed adding the Washington County Lead District – Furnace Creek area to their National Priorities List (NPL) on October 19, 2010 and added the site on March 10, 2011.

Lead mining in Washington County and the Furnace Creek area has a long history dating back to the early 1700's. Lead was originally found on or near the surface and later mined from shafts less than 10 feet deep in the red clay residuum and fractured bedrock by the pick and shovel method. Ore was raised in buckets, hand-separated from the surrounding rock, and cleaned of clay by shaking in a rattle box. Early lead miners tossed barite aside because it originally had few uses but was later found to be valuable as a long-lasting white pigment and later on as a weighting agent in oil drilling mud. Mechanization was first introduced in 1819 when a drill was used for blasting. By the late 1800's, a number of mines had penetrated the bedrock at depths of 100 feet or more. In 1904, a mining and milling company used an early steam shovel and wet-process mill to mine and separate the lead and barite, but hand mining remained the main method. In 1942, mechanized mining reemerged with the use of shovels and front-end loaders that mined the residuum. (1,2)

Past mining has left large and small areas of disturbed land along with associated water retention ponds or pits. These disturbed areas and diggings are situated throughout the Furnace Creek area. Five areas of concentrated mining and diggings are being considered study areas that are expected to receive further investigation. One of these is the 72 acre site known as the Furnace Creek Tailings pond and associated disturbed area. (1,3) See the Summary Table for a list of contaminants found in the Study Areas.

Site Investigations

Because elevated lead levels in other areas of Washington County associated with past mining activities required remediation work to protect public health, EPA began a removal assessment of the Furnace Creek area. The assessment began in June 2008, to determine if the Furnace Creek area had similar contamination. During the sampling event, EPA screened 428 residences and sampled 207 private drinking water wells. Results of the sampling effort found 145 properties with surface (0-1 inch) soil lead contamination above 400 parts per million (ppm) with 33 of these properties having lead contamination above 1,200 ppm. Of the 207 private wells sampled, three contained lead levels above EPA's Action Level of 15 parts per billion (ppb) that ranged from 17.7 to 82.2 ppb. (4,5) Levels of barium and cadmium were below EPA's Maximum Contaminant Level (MCL) used for public drinking water systems. Based on the finding of elevated lead levels in soil and groundwater, EPA began a Time-Critical Removal Action to remove the contaminated soil above 1,200 ppm and provide a temporary alternative water source to those with contaminated well water.

The EPA continued to sample other residential properties for lead, cadmium, and barium contamination. As of June 10, 2011, 1,050 properties have been found to not be contaminated, and 293 properties were found to have lead contaminated soil between 1,200 ppm and the EPA calculated public health action level of 430 ppm. EPA calculated the action level using their Integrated Exposure Uptake Biokinetic (IEUBK) model that predicts blood lead concentrations of children of up to 72 months of age to environmental lead contamination. Although the calculations came up with a slightly

higher lead level (430 ppm) based on the bioavailability of lead in the area, EPA used 400 ppm as the action level as they have at other lead sites. These properties fall into a Non-Time Critical Action Level category and would be cleaned up under a future Remedial Action. EPA declared 169 properties as high priority because they were (a) above a Time-Critical Removal Action level of 1200 ppm or (b) were above 400 ppm and were the property where a child that has an elevated blood-lead level resided. As of June 10, 2011, excavation and backfilling has occurred on over 159 properties. The remediation of the lead contaminated soil consists of removing up to 12 inches of soil (24 inches for gardens) or until the lead level is below 400 ppm and replacing with uncontaminated soil so no significant exposure is expected. There are still properties where access for remediation has not been granted, including 382 that were visited and no contact was made and another 200 properties where residents would not allow EPA access to have their yards sampled. (Reference #4 and personal communication with EPA's On-Site Coordinator)

During the screening of properties, 1,156 private wells were sampled. Of those, 16 were found to contain lead above the EPA Action Level of 15 ppb or above the EPA Maximum Contaminant Level (MCL) of 5 ppb for cadmium. Sampling at an indoor faucet found only four residences with lead levels above the EPA's Action Level. The others had some sort of water treatment device that lowered the lead concentration below the EPA Action Level. The four residences with levels above the EPA Action Level for lead were provided a temporary source of safe drinking water until a permanent solution can be found. (4) The Action Level for lead and MCLs are regulatory levels set by EPA for public drinking water systems. See Table B-1 in Appendix B for a summary of residential contaminants.

Source Areas/Study Areas

In the investigation of the Furnace Creek area, EPA also investigated and sampled areas where the Missouri Department of Natural Resources (MDNR) Inventory of Mines Occurrences and Prospects (IMOP) database had identified historical mining operations. EPA has identified five study areas where mining and disturbed land was present (See Figures 2 and 3). Soil, tailings ponds, drainage water ways, and sediment were sampled in February and April of 2010 (1,3). Elevated levels found during the sampling are listed in the Summary Table 1.

Most of the source sites are not easily accessible. During a site visit on June 23, 2011, a DHSS employee and the EPA On-Site Coordinator visited the Furnace Creek Tailing Area and pond (Area 22). Although the site was isolated and access was difficult, there were visible signs of some activities at the site, such as all-terrain vehicle riding, partying, and possibly fishing in the impoundment. Some foundation structures were also seen that could be a safety hazard if access to the structures was a common occurrence. The DHSS and EPA personnel also visited other areas of the site including residences with remediated yards.

From the MDNR's IMOP, there are listings of some zinc mines. During the June 23, 2011 site visit, the DHSS and EPA personnel visited one of these mines and found it to be on private property with limited access. In EPA's investigation of this site, no elevated levels of lead were detected. Although exposure is not expected, if more information or concern arises, the site will be further evaluated.

Summary Table

Washington County Lead District – Furnace Creek Area
Summary Table of Contaminants Found Elevated at Source Areas and Associated Drainage Streams from 2010 Site Inspection Report

Source Area	Media and Range of Contaminant In parts per million (ppm) unless otherwise noted			Screening Value
	Media	Lead	Arsenic	ATSDR currently doesn't have a screening value. EPA calculated a value of 430 ppm, but is remediating residential yards over 400 ppm of lead. Arsenic in soil - 15 ppm ATSDR EMEG – child ATSDR currently doesn't have a screening value for lead in water. EPA's Lead Action Level for public drinking water is 15 ppb.
Furnace Creek Mine	Soil/ Tailings	88.3 – 67,000	3.15 – 133	
Irondale Mine	Soil/ Tailings	223 – 195,000	7.32 – 42.8	
Forker Diggings	Soil/ Tailings	73.1 – 1,284	3.21 – 23.8	
Drainage Streams	Sediment	6.27J – 120,000	2.38 – 27.1	
Drainage Streams	Water	ND – 5.73 ppb (J)	ND	

Data from Reference #1
ATSDR EMEG = ATSDR Environmental Media Evaluation Guide
ppb = parts per billion
ND = not detected
J = The identification of the analyte is acceptable; the reported value is an estimate

Time-Critical Removal Actions for residences have been completed except for remediated sites that require repair and properties where access was not granted or no contact was made. To address those properties found to have a Non Time-Critical Removal Action level (below 1,200 ppm to a calculated health risk level), a Remedial Action will address those properties with lead contaminated soil/driveways and provide a permanent solution to the lead contaminated well problems. Because the site is so large and complicated, the Remedial Action will be broken down into four Operable Units (6). The Operable Units (OUs) for the Furnace Creek Remedial Action are:

OU-01	Residential Soils
OU-02	Groundwater
OU-03	Mine waste and railroad grades
OU-04	Surface water and sediment

Other Sources of Exposure to Contamination

Another source of lead exposure is to lead-based paint, especially for children under 72 months of age, since a large percentage of homes in Washington County were built before 1979. The use of lead-based paint in residential buildings was not restricted until 1978. In Washington County as a whole, 61% of the homes were built before 1979. Deteriorating and cracking lead paint and areas of friction where the lead paint is ground to dust are areas where children can easily be exposed to lead contamination through their high hand-to-mouth activity (7). Therefore, lead-based paint can be an additional source of lead exposure.

Air sampling for lead has not been done and is not considered a major pathway of exposure unless the material is disturbed. Considering that the tailings areas are mostly located in rural areas with some vegetation being present and not like the large tailings pile areas of St. Francois and Madison Counties, wind doesn't seem to affect and move the lead contaminated materials like it does at the large tailings piles. The air pathway could potentially be a problem for residents inside the homes or who live on or near unpaved roads where the lead contaminated materials were used as surface materials.

Washington County Health Department Activities

Prior to the Washington County Lead District – Furnace Creek area being listed as a NPL site, elevated blood-lead levels were known to be a problem in Washington County. The U.S. Centers for Disease Control and Prevention (CDC) used 10 microgram per deciliter (µg/dL) in the past as the blood-lead level at which public health actions should be initiated. At levels above 10 µg/dL, follow up and intervention have taken place to lower the child's blood-lead level (7). For the calendar year 2004, DHSS data show that in Washington County, 19% (348 children of the 2000 U. S. Census population of 1,844) of the children less than 72 months of age had their blood-lead tested. Of those tested, 5% (16 children) were found to have blood-lead levels above 10 µg/dL.

From more recent data, the percentage of children with elevated blood-lead levels has gradually decreased. DHSS data for 2007 show the percentage of children less than 72 months of age with blood-lead levels greater than 10 µg/dL in Washington County has decreased to 3% of the population tested (494 children tested out of a population of 1,844 or 27% tested). For 2011, DHSS data show that the percentage of children less than 72 months of age with blood-lead levels above 10 µg/dL had decreased to 1% (3 children) of the population tested (301 children out of a population 1,844 or 16.3% tested). Studies have found that there are health effects from blood-lead levels below 10 µg/dL and under the recommendation from its former Advisory Committee on Childhood Lead Poisoning; CDC began using a reference value of 5 µg/dL in 2012. For a complete explanation of the new reference value, see the Toxicological Evaluation Section. Using the new CDC reference value for blood-lead of 5 µg/dL, 27 children in Washington County had blood-lead levels between 5 and 9.9 µg/dL for those tested in 2012.

Factors that have contributed to the increased blood-lead testing numbers and lowered the percentage of children with blood-lead levels over 10 µg/dL were: increased provider (doctors, nurses, etc.) education, patient and community education about lead poisoning, increased effort by the Washington County Health Department (WCHD) to sample more children, and increased Medicaid funding and outreach for testing of children in low income families. EPA remediation of yards with high lead contamination at other NPL sites in Washington County has also contributed to the lower percentage of elevated blood-lead children on a county wide basis, but remediation activities in the Furnace Creek area are in the early stages and the benefits are gradually being seen in the 2012 DHSS data.

CDC previously considered 10 µg/dL or greater as the level of concern that a child was considered to have an elevated blood-lead level. In January 2012, CDC's Advisory Committee on Childhood Lead Poisoning Prevention (ACCLPP) recommended the use of a reference value of 5 µg/dL blood-lead level and that agencies shift priorities to primary prevention and provide guidance to respond to blood-lead levels above the reference value. CDC's new reference value is based on the 97.5^{th} percentile of blood lead levels among U.S. children 1-5 years of age, according to the National Health and Nutrition Examination Survey (NHANES) estimates. (8) Continued public health actions such as health education and blood-lead testing in Washington County should assist in implementing this new recommendation.

Because of the elevated blood-lead levels in Washington County children along with elevated lead levels found in soil and drinking water, EPA began a Time-Critical Removal Action in 2008. To inform the public of what to expect, EPA conducted a public availability session at the public high school in Caledonia, Missouri on May 28, 2008. As part of the availability session, DHSS and WCHD provided health education materials and answered health related questions from the public. On May 29, 2009, EPA conducted a public meeting to inform residents of their findings, follow-up activities, and to encourage others to have their property tested. As part of the meeting, DHSS provided health information and in cooperation with ATSDR and WCHD, provided free blood-lead testing to anyone at the meetings. None of the 14 blood samples taken were found to have blood-lead levels above CDC's new reference value of 5 µg/dL. Continued testing of children's and expectant mothers blood-lead level is needed to determine if remediation efforts and health education provided to the community will continue to lower blood-lead levels.

Elevated Blood-Lead Risk Assessment

In the past, when WCHD or a health care provider identifies a child with a blood-lead level above 10 µg/dL, the child was said to have an elevated blood-lead level. When a child is found to have an elevated blood-lead level, their health care provider, local county health department, and/or managed health care agency typically provides health education to the family on ways to reduce the child's blood-lead level. CDC has recently

starting using a reference value of 5 µg/dL and usually health education is provided to parents if their children's blood-lead level is greater than 5 µg/dL along with information on the possible sources of exposure. For every child with a blood-lead level at 15 µg/dL or greater, an Elevated Blood Level Risk Assessment is completed to find what is causing the child to have elevated levels of lead in his/her blood. In Washington County, the DHSS Bureau of Environmental Epidemiology's Childhood Lead Program conducts these Risk Assessments. These Risk Assessments typically include testing for lead in drinking water, yard soil, dust, lead-based paint, or other interior sources such as doorways, windowsills, window troughs, walls, toys, along with other areas the child may come into contact with lead. WCHD offers blood-lead testing for citizens of Washington County to determine if they have an elevated blood-lead level.

Land Use, Natural Resources, and Geology

Except for the small towns of Caledonia, Belgrade, and Irondale, the Furnace Creek area consists of rural residential properties mostly along roadways in the wooded northern portion of the site. The southwestern portion of the site is less wooded with open pastures and some cropland. Residences are still scattered and consist of single family housing areas on small to large acreage with private wells.

Historical mining in the area consisted of past lead and some barite mining in certain areas listed as the study areas. Other natural resources include forest land that was and is still being harvested to an extent, and the pasture and farmland of the southwestern part of the site. The Big River and smaller streams as well as small impoundments provide some recreation areas and places to fish.

Bedrock within the site area is dolomite (carbonate rock) that is susceptible to being dissolved or undergoing karstification. These carbonate formations in and near the study areas contain sinkholes, springs, losing streams, and caves. The site area is structurally complex with numerous faults present in the areas. The Ozark aquifer is the most important aquifer for water production. Underlying the Ozark aquifer is the St. Francois confining layer that hydrologically separates the Ozark aquifer from the deeper St. Francois aquifer. The St. Francois aquifer is a significant source of groundwater in the southern portion of the Furnace Creek site. Besides the fracturing between the aquifers, numerous exploration drill holes may also penetrate the confining layer and allow circulation between the aquifers. (1,3)

Demographics

Except for the small communities of Caledonia, Belgrade, and Irondale, the Furnace Creek area is primary rural residential with some businesses located mostly along state highways. The Furnace Creek area consists of approximately 175 square miles of wooded rolling hills that becomes flatter and less wooded with more pasture and some cropland in the southwestern portion of the site. As shown in Figures 2 and 3, five study

areas have been selected for further activity because they are centered on historical mining operations (1,3).

To determine the population of the Furnace Creek area, a demographic statistics map was developed by ATSDR using 2000 U.S. Census Data. The total population of the site and a one mile buffer zone was 9,080. The population of this area is 97.6% white, 0.29% black, 0.75% American Indian and Alaska Native, 0.1% Asian, less than 0.1% Native Hawaiian and other races, 1% two or more races, and 0.7% Hispanic or Latino. The percentage of children aged six and younger is 9.2%, and for adults aged 65 and older the percentage is 12.8%. The percentage of females aged 15 to 44 is 20.2% (See Figure 4). According to the 2000 U.S. Census, the percentage of families below the poverty level for 1999 in Washington County was 17.1%. The percentage of homes that were built before 1979 was 61% (9).

Quality Assurance and Quality Control

Various people, organizations, and contractors have been involved in the sampling, research, and analyses at this site, resulting in Quality Assurance and Quality Control (QA/QC) information of varying degrees of accuracy and precision. In preparing this public health assessment, DHSS and ATSDR have relied on the information provided in the referenced documents and have assumed that adequate quality assurance and quality control measures were followed with regard to chain-of-custody, laboratory procedures, and data reporting. The validity of the analysis and, therefore, the conclusions in this public health assessment are valid only if the referenced information is complete and reliable.

DISCUSSION

Pathways Analysis

Lead has been found to be the main contaminant at the Washington County Lead District – Furnace Creek Area and has contributed to elevated blood-lead levels in children less than 72 months of age. The five elements of the completed exposure pathway at the Washington County Lead District – Furnace Creek Area are:

1. **Contaminant source –** lead contaminated tailings, soils, ground and surface water, and other materials.
2. **Environmental medium and transport –** soil, groundwater, dust, surface water, sediment, fish, air, and garden vegetables.
3. **Point of exposure –** areas where exposure to lead contamination is taking place.
4. **Route of exposure** – ingestion and inhalation.
5. **Receptor population –** those that ingest and/or inhale lead contaminated materials.

Completed Exposure Pathways

Completed exposure pathways at the Washington County Lead District – Furnace Creek Area have existed in the past, are presently occurring, and will continue to occur in the future, until exposure to lead in soil and groundwater are reduced or eliminated. See Table B-2 in Appendix B for a list of exposure pathways. Lead is the primary contaminant of concern at the site. The major exposure pathway to lead is ingestion, with inhalation being a minor pathway.

Exposure to soil contaminants can occur through direct or accidental ingestion of soil while working, playing, gardening, or spending time in the yard. The contaminated soil can also be tracked indoors on shoes, by pets, and other methods and may accumulate in the home. Individuals, especially children, can accidentally ingest this contaminated dirt/dust in the home. Children are more likely to be exposed to household dust and other forms of contaminated media because of their high hand-to-mouth activity.

Although not as major of a route as ingestion, individuals can also be exposed to contaminated soil in the yard and contaminated dirt in the home through inhalation. When this soil or dust is stirred up and becomes airborne, individuals may breathe it in and cough up the dust to be swallowed. Lead is not readily absorbed through the skin, so dermal contact with lead contaminated soil is not a significant route of exposure.

Individuals can be exposed to the lead in water through ingestion while drinking and cooking with contaminated water. Individuals may accidentally ingest lead contaminated water while bathing, playing, or swimming. Dermal contact to lead in water is not a significant route of exposure.

In addition to exposure to soil and groundwater, the DHSS Childhood Lead Program along with the WCHD have identified children in the area with elevated blood-lead levels whose homes had elevated levels of lead in the indoor dust and/or lead-based paint. The high levels of lead in the indoor dust may have come from elevated levels of lead in outdoor soil, dust, or paint chips from lead based paint in the home, or other sources. This completes an exposure pathway through ingestion and/or inhalation of lead contaminated indoor dust.

EPA has greatly reduced exposure to lead-contaminated soil and groundwater by their Time-Critical Removal Action. The intent of an EPA Time-Critical Removal Action is to identify and eliminate critical exposure pathways in an expedient manner. For this Time-Critical Removal Action, EPA has removed soil from residential yards with lead concentrations of 1,200 ppm and above and yards with lead concentrations greater than 400 ppm that had a child in the residence less than 72 months of age with an elevated blood-lead level of 10 µg/dL and above. In addition, EPA has identified private drinking wells with levels of lead greater than 15 ppb. EPA has offered all of these residents an alternate water source to eliminate or reduce exposure as a temporary solution until a permanent solution is identified and implemented.

Potential Exposure Pathways

Potential exposure pathways consist mostly of those areas where the environment has not been tested for lead contamination. These include the water bodies associated with past disturbed mining areas and the streams that run through the site. Limited sampling has shown elevated levels of lead or other contaminants present in the water and sediment near the source areas, but not further downstream. Additional sampling is needed to determine if the water bodies and fish in them are being affected and contain lead at a level of health concern. Garden produce grown in lead contaminated soil or wild edible plants growing in mining disturbed soils could be a potential source of exposure. Exposures to these potential pathways may or may not be at a level of health concern.

TOXICOLOGICAL EVALUATION

Introduction

This section will discuss the health effects of exposure to specific contaminants found at the site. A discussion of non-cancerous health effects and the possibility of the contaminants causing cancer are evaluated in this section. ATSDR has developed Comparison values (CVs) that are media-specific concentrations used by health assessors to select environmental contaminants of concern. Contaminant concentrations that are less than the CV are unlikely to pose a health threat. Contamination levels above the CV do not necessarily indicate that a health threat is present, but they may indicate that further evaluation of the chemical and pathways is needed. CVs are usually developed for chronic (more than 365 days) exposure, intermediate (15 days to 365 days) exposure and acute (14 days and less) exposure. Environmental Media Evaluation Guides (EMEGs) are CVs that have been derived for a variety of chemicals in various media.

ATSDR has not developed a CV for lead. Instead, exposure to lead is evaluated by using an EPA biological model that predicts a blood-lead concentration that would result from exposure to lead levels found in the environment. The EPA risk reduction goal for lead contaminated sites is to limit the probability of a child's blood-level exceeding 10 µg/dL to 5% or less (10). CDC recently began using a reference value of 5 µg/dL for children's blood-lead level instead of the 10 µg/dL that was previously considered as having an elevated blood-lead level (8). Before the reference value, EPA used the model to establish a standard clean up value of 400 ppm for lead in soil using the default parameters in this model (10). The default parameters in the model include estimated soil ingestion and time spent outdoors. If the default parameters are found to be inaccurate in an area being investigated, the cleanup value used at that site may be different than 400 ppm.

Lead, and to a lesser extent cadmium, arsenic, and barium have been found in tailings piles, soils, groundwater, sediment, and surface water in and around areas of the Washington County Lead District – Furnace Creek Area. The tailings areas and

residential yards vary as to the amount of exposure that occurs in each area. Although lead is naturally occurring, the practice of depositing mine tailings above ground has made a large volume of lead contaminated materials more accessible to people. From natural processes and human intervention, the contaminated tailings have moved throughout the community in different media where exposure has occurred. Other sources of lead exposure is also possible in older homes where lead-based paint was used, along with the possibility that lead pipes and lead containing solder are present.

Lead

Lead is a naturally occurring bluish-gray metal found in small amounts in the earth's crust. It is mined and processed for use in various industries. It is used in some types of batteries, ammunition, ceramic glazes, medical equipment, scientific equipment, and military equipment. At one time, lead was used as an additive in gasoline and paint (11). Paint containing lead may still be present in older homes and becomes more available for uptake into the body if it is deteriorated or flaking. Tailings contaminated with lead have been deposited on the ground surface in tailings piles and also moved by nature and man into areas where exposure can easily occur (exams: yards and driveways).

The pathways of concern for lead exposure are ingestion and to a lesser extent inhalation. Lead dust that is breathed in and then cleared from the lungs may then be swallowed. Lead is not readily absorbed through the skin, so dermal contact is not an important route of exposure**.** The correlation between lead-contaminated soil and blood-lead level are influenced by many factors including: access to soil, levels of lead in soil, behavior patterns (especially of children), presence of ground cover, seasonal variation of exposure conditions, particle size and composition of lead compounds found at various sites, and the route of exposure (10). These complex factors explain, in some instances, discrepant findings that are reported in the literature (12).

Children are more sensitive to the effects of lead than adults. The Centers for Disease Control and Prevention (CDC) considers lead poisoning to be the number one preventable health problem facing children in the U.S. (7). No safe blood-lead level (BLL) in children has been determined. Until recently, children were identified as having a blood-lead level of concern (elevated BBL) if the result was 10 microgram per deciliter (10 µg/dL) or greater of lead in the blood (7,11). CDC recently began using a reference value of 5 µg/dL, the 97.5^{th} percentile of blood lead in a representative sample of children in the U.S. 1-5 years of age. In other words, 2.5% of these children had blood-lead levels at or above 5 µg/dL. Children identified with BLL greater than or equal to 5 µg/dL should prompt public health actions and agencies should shift priorities to primary prevention and provide guidance to respond to blood-lead levels above the reference value as recommended in the report of the Advisory Committee on Childhood Lead Poisoning Prevention: *Low Level Lead Exposure Harms Children: A Renewed Call for Primary Prevention* (January 4, 2012). Health effects of lead poisoning at these BLLs include decreased attention span, hyperactivity, and lower IQ scores. Needleman and Gatsonis report that children's IQ scores are inversely related to blood-lead levels.

Several studies provide sufficient evidence that children's mental process or the faculty by which knowledge is acquired was adversely affected by lead (12).

Lead has no nutritional benefits for humans and has its greatest adverse effect on the nervous system, especially in children. An unborn child can also be exposed to lead if their mother has lead levels in her body. This exposure can cause problems such as premature births, low birth weight, decreased mental ability, learning difficulties, and reduced growth as young children. Young children can also be exposed to lead through their mother's breast milk if the mother has elevated blood-lead levels in her system (11).

The biologic fate of inorganic lead in the human body is well known. Inorganic lead is not metabolized but is directly absorbed, distributed, and excreted. Once in the blood, lead is disturbed primarily among three compartments – blood, soft tissue (kidney, bone marrow, liver, and brain), and mineralizing tissue (bones and teeth). Mineralizing tissue contains about 95% of the total body burden of lead in adults (11).

Lead can also enter the body by drinking lead-contaminated water. EPA has found 16 private wells that exceeded its Public Drinking Water Action Level for lead, of which only four exceeded that level at the tap because the other residences had some sort of treatment device. For those four private wells EPA has provided an alternative source of drinking water.

Cadmium

Cadmium is a soft, silver-white metal that occurs naturally in the earth's crust. Cadmium is not usually present in the environment as a pure metal, rather as a mineral combined with other elements. It is most often present in nature as complex oxides, sulfides, and carbonates in zinc, lead, and copper ores. Cadmium has many industrial uses and is used in consumer products including batteries, pigments, metal coatings, plastics, and some metal alloys. (13)

The exposure route of concern for cadmium in Washington County is ingestion of contaminated drinking water. Low levels are present in most foods with the highest levels present in shellfish, liver, and kidney meats. Cigarette smoke also contains cadmium and can double an individual's daily intake. Ingestion of high levels of cadmium in contaminated food or water can severely irritate the stomach, leading to vomiting and diarrhea, and sometimes death. Cadmium is a cumulative toxicant and ingestion of lower levels for a long period of time can lead to a buildup of cadmium in the kidneys and, possibly, kidney damage. The kidney is the main target organ for cadmium toxicity following chronic-duration exposure by oral routes. The EPA has classified cadmium as a probable human carcinogen while the National Toxicology Program (NTP) has classified cadmium as a known human carcinogen by inhalation. The classifications are based on limited human data and studies on rats. Studies on humans and animals ingesting cadmium have not found increases in cancer, although additional research is needed. (13)

ATSDR has developed a chronic EMEG for cadmium in soil of five parts per million (ppm) for a child and 70 ppm for adults. The level of cadmium that was detected in soils/driveways ranged from being not detectable to a maximum of 26.3 ppm. The elevated levels of cadmium are associated with elevated levels of lead and should be remediated along with the lead contamination.

Cadmium was mostly non-detectable in the private wells that were sampled, but a few had detectable levels up to a maximum of 5.94 parts per billion (ppb). ATSDR has developed a chronic EMEG for cadmium in water of 1 ppb for a child and 3.5 ppb for an adult. EPA also has a Maximum Contaminant Level (MCL) of 5 ppb for public water supplies. Considering that the majority of private wells were non-detect for cadmium and the few with detectable cadmium either had a treatment device or were provided an alternative source of drinking water, no adverse health effects are expected.

Arsenic

Arsenic is an element that is widely distributed in the earth's crust. Inorganic arsenic occurs naturally in soils and many kinds of rock, especially in minerals and ores that contain copper and lead. Inorganic arsenic is expected to be the form present at the site. Arsenic cannot be destroyed in the environment; however, it can change its form or become attached or separated from particles. It can change its form by reacting with oxygen or other molecules present in air, water, or soil, or by the action of bacteria that live in soil or sediment. (14)

The pathway of uptake for arsenic at the site is ingestion. Arsenic contaminated soil, sediment, or water on the skin is a minor exposure pathway at this site; however, direct skin contact with high concentrations of inorganic arsenic compounds may cause the skin to become irritated with some redness and swelling. It does not appear that skin contact is likely to lead to any serious internal effects. Skin exposure to the low levels of arsenic at this site is not a concern. After ingestion or inhalation exposure to arsenic, the liver changes some of the arsenic to a less harmful organic form, which is excreted in the urine. Most of the arsenic will be gone within several days, but some will remain in the body for several months or longer. Inorganic arsenic has been recognized as a human poison since ancient times, and large oral doses (above 60 ppm in food or water) can cause death. Smaller doses of inorganic arsenic (0.3 to 30 ppm in food or water) may cause irritation of the stomach and intestines, with symptoms such as stomach ache, nausea, vomiting, and diarrhea. Other effects from ingestion of inorganic arsenic include decreased production of red and white blood cells which may cause fatigue, abnormal heart rhythm, blood vessel damage resulting in bruising, and impaired nerve function causing a "pins and needle" sensation in the hands and feet. (14)

ATSDR has developed an EMEG for arsenic in soil of 15 ppm for children and 210 ppm for adults for chronic exposure (greater than 365 days). ATSDR has also developed an acute value (14 days or less) of 10 ppm for the pica child. A pica child has a craving to

put non-food items in their mouths or eat non-food items such as dirt, paint chips, etc. ATSDR has also developed a chronic EMEG for arsenic in water of three parts per billion (ppb) for a child and 11 ppb for an adult. (14) Arsenic was determined to not be a contaminant of concern at residential properties and was not analyzed for in soil and well water.

Source areas have been found to have elevated levels of arsenic. Elevated levels of arsenic in soil were found above ATSDR's EMEG for a child but not an adult at some source areas. Arsenic in drainage streams at the source areas was not detected. However, since the source areas are usually isolated, the time spent in the source areas is expected to be limited with only short-term exposure that is not expected to cause any adverse health effects. Elevated arsenic contamination in the source areas should be considered in future remedial actions at the site.

EPA's removal of the lead contaminated soil will also address any arsenic contaminated soils that may be present in residential yards and the possibility of exposure.

Barium

Barium is a silvery-white metal that is found in barite ores containing mixtures of elements. When combined with other chemicals such as sulfur or oxygen, it forms barium compounds. These compounds are used to make paint, bricks, ceramics, glass, rubber, and other products. Barium compounds are also used by the oil and gas industries to make drilling mud that makes it easier to drill through rock by keeping the drill bit lubricated. (15)

The health effects of the different barium compounds vary depending on how well the compound dissolves in water or in the stomach. Barium compounds that do not dissolve well, such as barium sulfate, are generally not harmful. In fact, doctors sometimes use barium sulfate when performing some medical tests and taking x-rays of the gastrointestinal tract. (15)

Barium is sometimes found naturally in drinking water and food. The barium compounds that are usually found naturally do not dissolve or mix well with water, so the amount of barium found occurring in drinking water naturally is usually small. Certain foods, such as Brazil nuts, seaweed, fish, and some plants, may contain high concentrations of barium, but the concentration is not usually enough to be a health concern. (15)

Over 1500 properties have been sampled in the Washington County Lead – Furnace Creek site and the detection of barium in soil/driveways ranged from 18.9 ppm to 9,040 ppm. These levels are below ATSDR's EMEG for a child of 10,000 ppm. With the maximum level of barium detected being below the chronic EMEG for a child, no adverse non-cancerous health effects are expected to occur. Of the over 1100 private wells that were tested, the maximum level of barium was 1,150 ppb which is below ATSDR's chronic EMEG for a child at 2,000 ppb and EPA's MCL. No non-cancerous

adverse health effects are expected from the exposure to barium in the private well water tested.

Cancer

The American Cancer Society estimates that in the United States, slightly less than half of all men and slightly more than one-third of all women will develop some form of cancer in their lifetime (16).

The EPA considers lead to be a probable human carcinogen and the National Toxicology Program (NTP) has determined that lead and lead compounds are reasonably anticipated to be human carcinogens based on limited studies (17). There has been no studies linking residential ingestion or inhalation of lead contaminated soil or drinking water to increased cancer risks. The primary health concern for lead at the Washington County Mining District – Furnace Creek area is not cancer. Rather the primary concern is lead's effect on the nervous system, especially for children less than 72 months of age.

Cadmium is considered by EPA to be a probable human carcinogen (limited human, sufficient animal studies) from inhalation, a known human carcinogen by NTP and is considered to be carcinogenic to humans by the International Agency for Research on Cancer (IARC). An association has been found between occupational inhalation exposure to cadmium and lung cancer (13). Although no air sampling has been done in Washington County, concentrations of cadmium are not expected to be anywhere near occupational levels, and no carcinogenic health effects are expected.

Barium has not been shown to cause cancer in humans. The EPA has determined that barium is not likely to be carcinogenic to humans following ingestion and that there is insufficient information to determine whether it will be carcinogenic to humans following inhalation exposure. The International Agency for Research on Cancer (IARC) and NTP do not have a designation on barium as causing cancer. (15)

Arsenic is considered by EPA, the IARC, and the NTP to be a human carcinogen by the inhalation and ingestion exposure routes. Exposure through the inhalation route in workers has shown the predominant carcinogenic effect of increased risk of lung cancer. In general, most researchers observe that risk increases as a function of exposure and duration. Most of the research on arsenic causing lung cancer comes from studies involving workers at copper smelters and arsenical chemical plants. When exposure occurs by the ingestion route, the main carcinogenic effect is increased risk of skin cancer. This is based on epidemiological studies of populations exposed to levels of arsenic in drinking water. Other studies have shown that inorganic arsenic can also increase the risk of bladder, liver, kidney, and prostate cancer (14). Since arsenic was detected only in some source areas, exposure is not likely and carcinogenic health effects are not expected.

Mixtures

Lead is the major contaminant of concern at this site. Although lead's greatest damaging effect on the human body is to the nervous system, it can also damage the kidneys with exposure to high levels. Cadmium can also affect the kidneys after long-term exposure to low levels. Although both lead and cadmium can affect the kidneys, given the low levels of exposures, no expected synergistic (more than just additive) health impacts are expected (11,13). The cleanup of contaminated residential yards and providing an alternative drinking water source for contaminated private wells by EPA should further reduce any exposure.

Children's Health Considerations

In general, children are more likely than adults to be exposed to contaminants in soil and water. In their daily activities, children have a tendency for frequent hand-to-mouth contact and often introduce non-food items into their mouths. Because children are smaller, their bodies/organ/nervous systems are still developing; they typically absorb more of the contaminants. So, it usually takes less of a contaminant to cause adverse health effects in children than adults (11).

Children are more susceptible to lead poisoning than adults, and children are also more likely to be exposed to lead contaminated materials. Infants and young children can swallow and breathe lead in dirt, dust, or sand while they play on the floor or ground. They can also be exposed to lead through breast milk if the mother has elevated levels of lead in her system. Also, compared to adults, a larger proportion of the amount of lead swallowed will enter the bloodstream in children (11). While about 99% of the amount of lead entering the body of an adult will leave as waste within a few weeks, only about 32% of lead taken into the body of a child will leave as waste (11). All of these factors result in children being more affected by lead than adults at similar lead concentrations in their environment.

When children are exposed to lead-contaminated materials, a variety of adverse health effects can occur depending on the level of lead to which they are exposed and the duration of exposure. These effects include learning disabilities, slowed growth, hyperactivity, impaired hearing, and at very high exposure levels, even brain damage. Unborn children can also be exposed to lead through their mothers and are at risk of premature birth, low birth weight, decreased mental ability, learning difficulties, and reduced growth as young children (11).

Children who exhibit pica behavior may be at an even greater risk of exposure to contaminants in soil than other children. Individuals who exhibit pica behaviors have a craving to put non-food items in their mouths or eat non-food items such as dirt, paint chips, etc. (11).

Health studies have shown that adverse health effects can occur in children with blood-lead levels below 10 μg/dL (7,10). In 2012, CDC adopted the recommendation by the

Advisory Committee on Childhood Lead Poisoning Prevention (ACCLPP) to begin using a "reference value" that is based on the 97.5th percentile of blood-lead level distribution in U.S. children aged 1-5 years. That level is currently 5 μg/dL of blood (8). Yearly blood-lead testing before a child is 72 months of age is key to determining if the child has been exposed. Even soil lead levels of 400 ppm and below and drinking water containing lead at 14 ppb and below may still present a risk that could affect the blood-lead level of a child, especially considering the other potential sources of lead in the area. Eliminating exposure pathways by controlling contamination sources, practicing good personal hygiene, and eating a proper diet high in calcium, iron, and vitamin C can lessen the risk of lead poisoning (7).

COMMUNITY HEALTH CONCERNS

Starting in 2008, EPA began collecting soil and water samples from residential properties to determine if the Furnace Creek area of Washington County has been affected from past mining activities similar to the northeast portion of Washington County. EPA held a public availability session on May 28, 2008 to notify the public of their planned activities to sample residential yards and source areas. DHSS provided health education information at the availability session, but no community health concerns were expressed. On May 29, 2009, EPA conducted a public meeting to inform the public of the results of their sampling activities, follow-up activities, and encourage others to have their properties sampled for contamination. As part of the public meeting, DHSS in cooperation with the WCHD and ATSDR offered free blood-lead screening for those interested. None of the blood-lead levels of the 14 sampled were found to be above the new CDC reference value of 5 μg/dL. Few public health concerns were expressed during the meeting. Residents found to have elevated levels of lead in their yards were usually willing to have their yard remediated. However, some residents will not permit their property to be sampled, and EPA has not been able to make contact with all of the residents to offer screening of their property.

Conversations with personnel from the WCHD who interact with the public on a daily basis indicated that there really are not any health concerns about the lead contamination unless a parent's child is found to have an elevated blood-lead level.

CONCLUSIONS

DHSS has reached four important conclusions in this public health assessment:

1. Ingesting (swallowing) and/or inhaling (breathing) lead contaminated soil, dust, or tailings found in many of the residential yards/driveways within the Furnace Creek Area may harm individuals' health and is considered a public health hazard. This conclusion applies to past, present, and future exposure to lead at this site.

2. Drinking water with lead and cadmium contamination above EPA guidelines from untreated private well water may harm people's health and is considered a public health hazard. For those residents with contaminated well water but are using the EPA-provided alternative source of water, there is no longer a health concern. Skin contact with or breathing in lead or cadmium in a drinking water well is not expected to harm people's health.

3. For the past, present, and future, residents and especially children and expectant mothers can be exposed to lead from a number of sources that could harm their health. Residences built before 1978 containing lead-based paint and/or have access to remnants/areas of past mining, milling, and smelter activities may have an additional source of exposure to lead at levels of a health concern.

4. DHSS cannot currently conclude whether exposure to lead through air, sediment, surface water, fish, and edible plants in the Furnace Creek Area that have not been sampled could harm individuals' health. Physical hazards are also expected to exist in the past mining areas. The information needed to make decisions is not available. Limited sampling has been done on some drainage streams from the mined areas to determine the amount of lead contamination. However, sampling is being expanded to include other sources of exposure to lead and other contaminants from the impounded waters, fish, and other possible sources.

RECOMMENDATIONS

1. DHSS/ATSDR recommends that EPA continue to investigate and remediate appropriately residential yards, driveways, and other areas where individuals, especially children and expectant mothers, might be exposed to lead and possibly other contaminants.

2. DHSS/ATSDR recommends that EPA continue to identify and sample private wells in the area to determine the presence and levels of lead and possibly other contaminants and take permanent actions to prevent exposure to drinking water with elevated levels of contaminants. Residents with lead contamination below the EPA lead Action Level should follow guidelines to lower exposure from possible lead being contributed by the water pipes by flushing their water taps before using the water for drinking, cooking, making baby formula, or brushing their teeth or add a household filter system to reduce exposure.

3. Indoor dust may contain lead from a variety of sources, including lead based paint. Therefore, all agencies involved in remediation efforts in Washington County will work toward educating the public on how to reduce or eliminate their exposure to all sources of lead, including lead dust which often comes from lead-based paints. Lead paint remediation should be done using EPA guidelines or a certified lead abatement contractor.

4. DHSS/ATSDR recommends that EPA sample other sources, such as air, sediment, surface water, fish, and edible plants, to determine whether exposure to lead in other sources can harm human health.

5. DHSS/ATSDR recommends that EPA eliminate physicals hazards left from past mining activities as appropriate when found.

6. WCHD/DHSS will continue their efforts at targeted blood lead testing of children known to live in communities with high lead exposure sources.

7. WCHD/DHSS will continue their efforts to provide health education in communities known to have high lead exposure sources on the adverse health effects of lead exposure, stressing the importance of preventing lead exposures.

PUBLIC HEALTH ACTION PLAN

This Public Health Action Plan (PHAP) for the Washington County Lead District – Furnace Creek Area contains a description of actions underway and planned by the Missouri Department of Health and Senior Services (DHSS), the Agency for Toxic Substances and Disease Registry (ATSDR), and other stakeholders. The purpose of the PHAP is to ensure that this public health assessment not only identifies hazards that may harm health, but provides an action plan to mitigate and prevent adverse human health effects resulting from past, present, and future exposures to hazardous substances at or near the site. Below is a list of commitments of public health actions by DHSS, ATSDR, or other site stakeholders.

Actions undertaken:

1. EPA conducted a public availability session in 2008 to inform the public of their investigation process and DHSS, ATSDR, and the Washington County Health Department (WCHD) provided health education materials and answered health questions.

2. EPA conducted a public meeting in 2009 to inform residents of their findings, follow-up activities, and to encourage other residents to have their property tested while DHSS, ATSDR and WCHD provided free blood-lead testing, health information, and answered health questions.

3. EPA has removed soils from residential yards/driveways containing lead concentrations that exceed their Time-Critical Removal Action levels. These yards contained soil with lead contamination at a concentration of 1,200 ppm and greater or lead concentrations of 400 ppm and above for those that had a child less than 72 months of age with an elevated blood-lead level.

4. EPA has provided, as a temporary measure, an alternative source of drinking water to residents who have elevated levels of lead in their private drinking water wells.

Actions planned:

1. During the Remedial Action phase, EPA will continue to sample residential yards/driveways and private wells and remediate as necessary to prevent exposure.

2. EPA is expected to further sample other media, such as air, sediment, surface water, fish, and edible plants, so it can be determined if exposure to these media can harm people's health.

3. DHSS/ATSDR will work with the WCHD and EPA to provide health education for the residents of the Furnace Creek area so they can help reduce or eliminate their exposure to all sources of lead.

4. DHSS/ATSDR will continue to coordinate with the WCHD, MDNR, and EPA to address community health concerns and questions as they arise by providing health professionals and community health education.

5. DHSS/ATSDR will work with the WCHD to promote prevention of lead exposure from all sources and encourage residents of Washington County to have yearly blood-lead testing of children less than 72 months of age and expectant mothers.

6. DHSS/ATSDR will work with the WCHD to encourage residents of Washington County to have their yard soils and private drinking water wells tested for lead and remediated if elevated levels are found.

7. DHSS/ATSDR will coordinate with the WCHD, MDNR, and EPA to implement the recommendations in this public health assessment.

8. DHSS/ATSDR will review additional sampling data from further investigations and provide guidance regarding possible health risk.

9. DHSS/ATSDR will update this public health assessment as needed.

REPORT PREPARATION

This Public Health Assessment for the Washington County Lead District – Furnace Creek Area site was prepared by the Missouri Department of Health and Senior Services under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with the approved agency methods, policies, procedures existing at the date of publication. Editorial review was completed by the cooperative agreement partner. ATSDR has reviewed this document and concurs with its findings based on the information presented.

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APPENDIXES

Appendix A

Figures:

Figure 1: Washington County Lead District – Furnace Creek Area Location Map
Figure 2: Washington County Lead District – Furnace Creek Area Sampling Points and Surface Water Pathways Segments
Figure 3: Washington County Lead District – Furnace Creek Area Field Screening Results for Residential and School Properties
Figure 4: Washington County–Furnace Creek Area Location and Demographic Statistics

Appendix B

Tables:

Table B-1: Summary of Residential Contaminants in the Washington County Lead District – Furnace Creek Area from 2009 Start 3 Laboratory Data
Table B-2: Washington County Lead District – Furnace Creek Area Exposure Pathways

Figure 1

Washington County Lead District – Furnace Creek Area Location Map

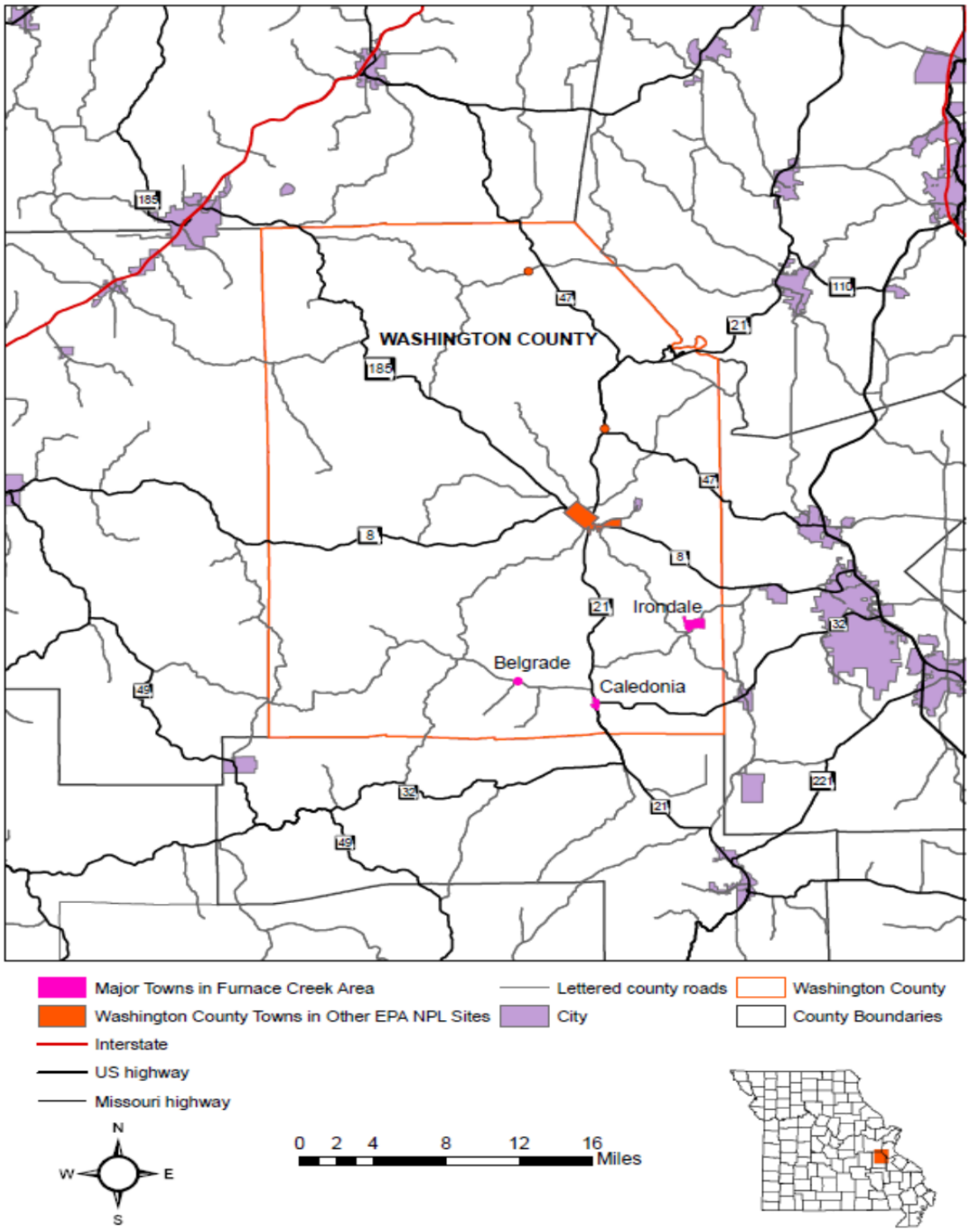
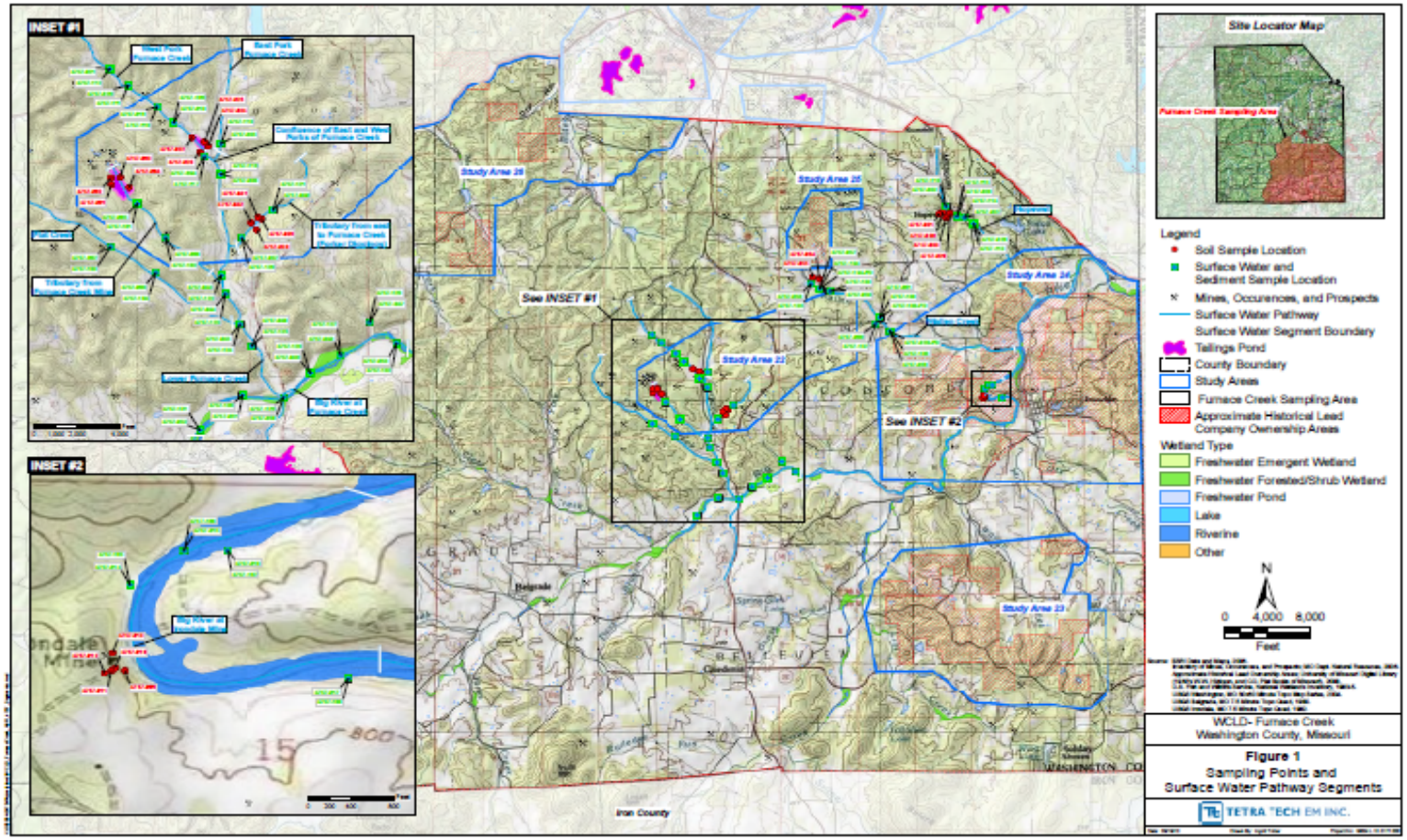


Figure 2
Washington County Lead District – Furnace Creek Area
Sampling Points and Surface Water Pathways Segments

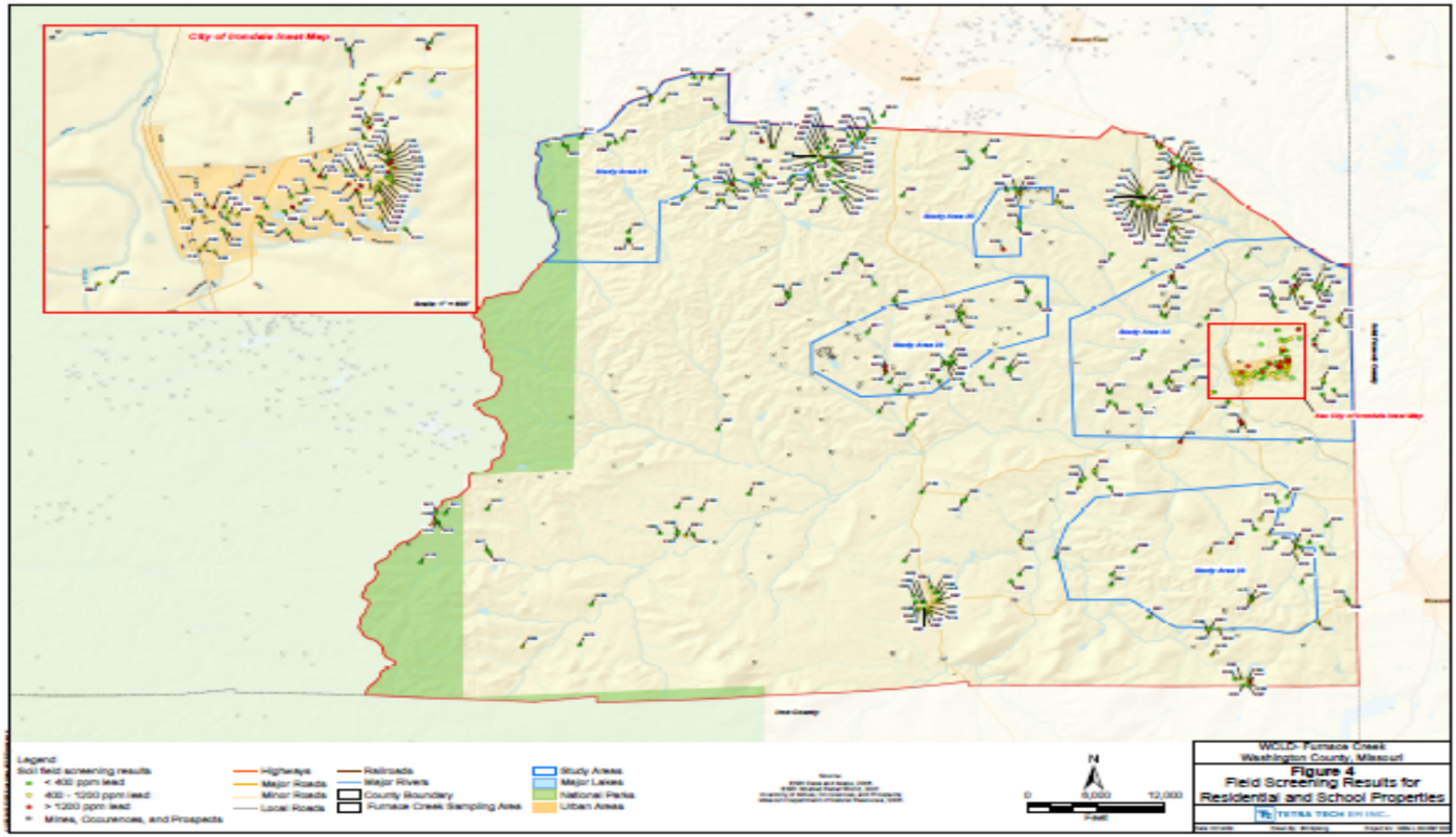


Source: Tetra Tech EM Inc., Site Inspection Report, Washington County Lead District – Furnace Creek, Washington County, Missouri. 2010

Figure 3

Washington County Lead District – Furnace Creek Area

Field Screening Results for Residential and School Properties



Source: Tetra Tech EM Inc. Removal Site Evaluation Report Washington County Lead District – Furnace Creek Area. 2009

Figure 4

Washington County–Furnace Creek Area Location and Demographic Statistics

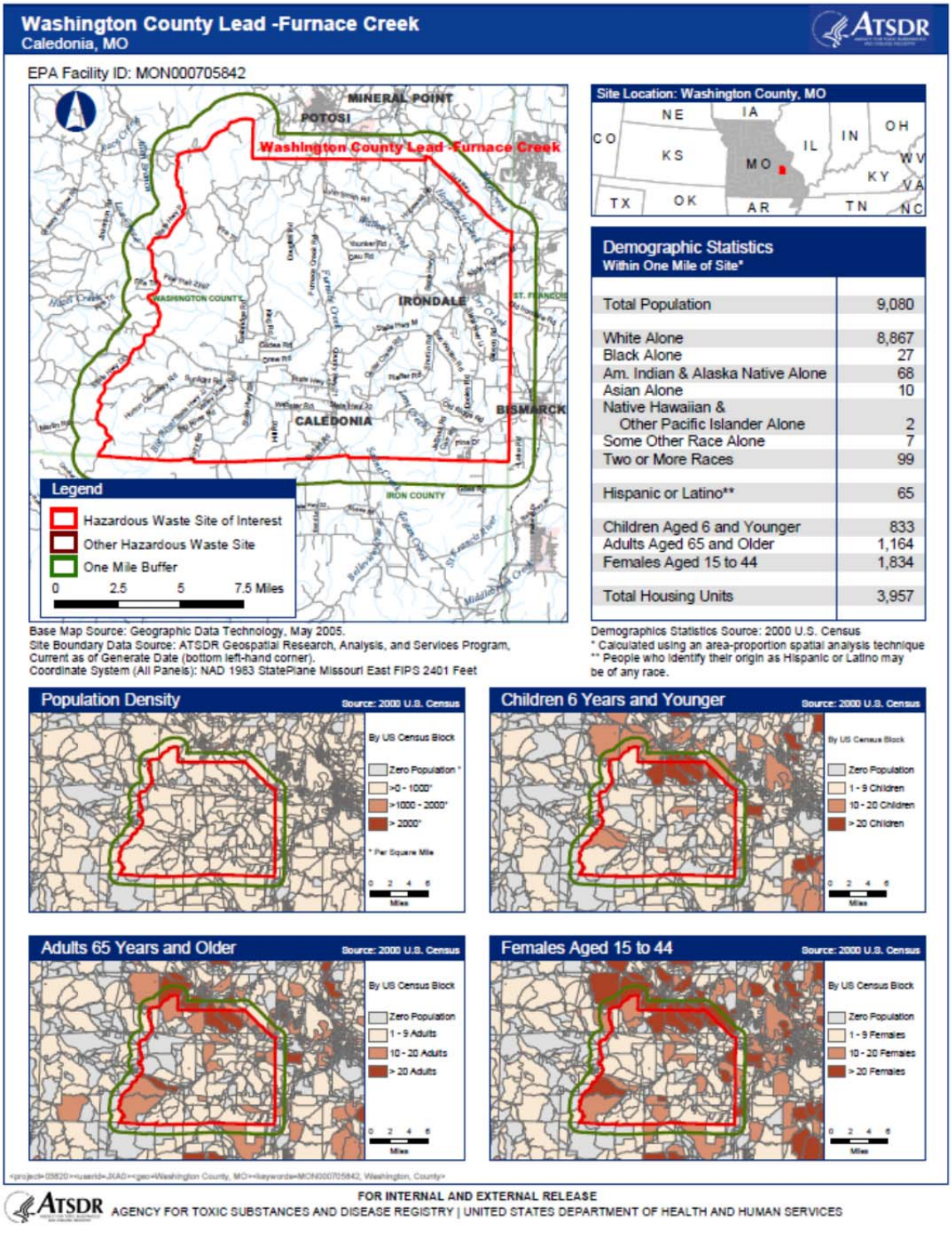


Table B-1

**Summary of Residential Contaminants in the Washington County Lead District—
Furnace Creek Area from 2009 START 3 Laboratory Data and Site Inspection Report May 19, 2010**

Contaminant	Locations	Media	Range of Contaminants	Screening Value & Source
Lead	Residences	Soil/Driveways	198 – 6,800 ppm	ATSDR currently doesn't have a screening value. EPA calculated a value of 430 ppm but is remediating yards over 400 ppm of lead. *
Cadmium	Residences	Soil/Driveways	ND – 26.3 ppm	5 ppm ATSDR EMEG child
Barium	Residences	Soil/Driveways	18.9 – 9,040 ppm	10,000 ppm ATSDR EMEG child
Lead	Drinking Water Wells	Water	ND – 82.2 ppb	ATSDR currently doesn't have a screening value for lead in water;15 ppb EPA PDWS
Cadmium	Drinking Water Wells	Water	ND – 5.94 ppb	1 ppb ATSDR EMEG; 5 ppb EPA MCL†
Barium	Drinking Water Wells	Water	ND –1,150 ppb	2,000 ppm ATSDR EMEG: 2,000 ppb EPA MCL

ppm = parts per million
ppb = parts per billion
ND = Not Detected
ATSDR EMEG = Agency for Toxic Substances and Disease Registry Environmental Media Evaluation Guide
EPA PDWS = Environmental Protection Agency Public Drinking Water Action Level
EPA MCL = Environmental Protection Agency Maximum Contaminant Level for Public Water Supplies
*Residential soils above 1,200 ppm of lead were remediated under a time-critical removal action. Levels between 1,200 and 400 ppm are expected to be remediated under a Remedial Action.
†EPA is using their MCL as the level to provide alternative drinking water

Table B-2

Washington County Lead District – Furnace Creek Area Exposure Pathways

Pathway Name	Exposure Pathways Elements					Time	Type of Pathway
	Source	Environmental Medium	Point of Exposure	Route of Exposure	Receptor Population		
Soil	Mining and Smelting Waste	Soil	Smelting and Tailings Areas, Private Yards, and Driveways	Ingestion and Inhalation	Residents, Visitors, and Transient Populations	Past, Present, and Future	Completed
Indoor/Outdoor Dust	Mining/Smelting Waste and Lead Contaminated Paint	Dust	Inside Homes and Areas of Generated Dust	Ingestion and Inhalation	Residents, Visitors, and Transient Populations	Past, Present, and Future	Completed
Groundwater	Mining and Smelting Waste	Groundwater	Private Drinking Wells	Ingestion	Residents, Visitors, and Transient Populations	Past, Present, and Future	Completed
Sediment	Mining and Smelting Waste	Sediment	Tailings Areas, Streams, and Ponds or Lakes	Ingestion	Residents, Visitors, and Transient Populations	Past, Present, and Future	Potential
Surface Water	Mining and Smelting Waste	Surface Water	Area Streams and Lakes	Ingestion	Stream and Lake Users	Past, Present, and Future	Potential
Fish	Mining and Smelting Waste	Fish	Locally Caught Fish	Ingestion	Individuals Eating Locally Caught Fish	Past, Present, and Future	Potential
Edible Plants	Mining and Smelting Waste	Edible Plants	Locally Grown or Gathered Plants	Ingestion	Gardeners and Individuals Eating Plants Gathered in the Area	Past, Present, and Future	Potential